

## Zinc Oxide Nanoparticles Synergistically Promote Zinc Uptake and Antioxidant Profile in Pepper Plants Subjected to Drought Stress

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### Abstract

Drought is one of the major environmental problems that severely affects plant development and yield. Several methods are currently being investigated to mitigate the harmful effects of drought stress on plants. The use of nanoparticles in agriculture is becoming increasingly popular globally. In this study, the zinc oxide nanoparticles (ZnO-NPs) were synthesized and structurally characterized using scanning electron microscopy and X-ray crystallography. The effectiveness of foliar spraying of ZnO-NPs was analyzed to increase zinc uptake in peppers and reduce oxidative stress during drought. The seedlings were treated with foliar spraying of synthesized ZnO-NPs at 0, 150, and 300 ppm doses under control and stress conditions. Zinc content in pepper roots and leaves and the activity of antioxidant enzymes, such as glutathione reductase, reduced glutathione, ascorbate peroxidase, peroxidase, catalase, dehydroascorbate reductase, and monodehydroascorbate reductase were analyzed. The accumulation of reactive oxygen species was associated with an increase in oxidative damage. However, treatment with ZnO-NPs reduced oxidative damage by promoting antioxidant enzymes and improved zinc uptake under all tested conditions, with the 300 ppm ZnO-NPs treatment depicting the greatest efficacy. The use of synthetic ZnO-NPs is a feasible approach to mitigate the negative effects of drought on the antioxidant systems and the ability to uptake zinc in pepper plants.

**Key Words:** *Pepper, Nanoparticles, Drought, Antioxidants, Zinc*

